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By: Teresa Anderson
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REQUEST FOR PROVISIONAL APPLICATION UNDER 37 C.F.R. § 1.53(c)

MAIL STOP PROVISIONAL PATENT APPLICATION
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This is a request for filing a Provisional application for patent under 37 CFR § 1.53(c) entitled Liquid Filter Assembly; And, Methods by the following inventor(s):

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1. ☒ Enclosed is the Provisional application for patent as follows: 31 pages of specification, and 5 sheets of drawings.

2. ☐ Small entity status is claimed pursuant to 37 CFR 1.27.

3. ☒ Payment of Provisional filing fee under 37 C.F.R. § 1.16(k) :
   - ☒ Attached is a check in the amount of $ 160.00.
   - ☐ Please charge Deposit Account No. 13-2725.

☐ PAYMENT OF THE FILING FEE IS BEING DEFERRED.

4. ☒ The Commissioner is hereby authorized to charge any additional fees as set forth in 37 CFR §§ 1.16 to 1.18 which may be required by this paper or credit any overpayment to Account No. 13-2725.

5. ☐ Enclosed is an Assignment of the invention to , Recordation Form Cover Sheet and a check for $ to cover the Recordation Fee.

6. ☐ Also Enclosed:

7. ☐ The invention was made by the following agency of the United States Government or under a contract with the following agency of the United States Government:

8. ☒ Address all future communications to the **Attention of Randall A. Hillson** (may only be completed by attorney or agent of record) at the address below.

9. ☒ A return postcard is enclosed.

Respectfully submitted,

23552
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LIQUID FILTER ASSEMBLY; AND, METHODS

Field of the Invention

The invention relates generally to liquid filters and methods. An example embodiment described, is an in-tank filter, for use, for example, in a hydraulic system.

Background of the Invention

Liquid filters are employed in a variety of applications, including, for example, hydraulic systems, fuel systems and engine lubrication systems.

In general, liquid filters which accommodate downstream components, are of concern. Particularly, it is of concern to prevent cavitation of pumps and other equipment downstream from liquid filters. Conditions such as cold starts, flow surges or occluded elements can result in damaged downstream components. Improvements are desirable.

Summary of the Invention

A liquid filter assembly is provided. The liquid filter assembly generally includes a housing and a suction filter assembly. The housing defines an interior and includes a liquid flow inlet, a liquid flow outlet, and a reservoir liquid flow inlet/outlet. The suction filter assembly is secured to the housing and is positioned in liquid flow communication with the liquid flow inlet/outlet. The suction filter preferably includes an extension of suction filter media defining a central volume; and, a first, non-helical spring, directionally biased valve arrangement positioned within the central volume. The first, non-helical spring, directionally biased valve arrangement is generally positioned and configured to readily permit liquid flow from the suction filter media through the first, non-helical spring, directionally biased valve arrangement and then

through the reservoir liquid flow inlet/outlet into the housing interior. The first, non-helical spring, directionally biased valve arrangement is also configured to resist liquid flow from the housing interior through the first, non-helical spring, directionally biased valve arrangement and into the suction filter media.

In a typical embodiment, the first, non-helical spring, directionally biased valve arrangement comprises a valve sheet having at least one cut valve therein, positioned within an outer support that has at least one flow aperture therein. A typical valve sheet would comprise a valve ring-shaped member having at least one and typically a plurality of cut valves, for example flap valves, therein. Typical flap valves would be u-shaped flap valves, for example curved u-shape flap valves or boxed u-shape flap valves.

A typical embodiment further includes a flow/pressure regulation valve or valve assembly. Typical preferred configurations is one in which the flow/pressure regulation valve is positioned within the suction filter assembly at a location surrounded by the suction filter media and in a position configured to regulate and selectively release flow from the housing interior to a reservoir, as a result of liquid flow passage through the reservoir liquid flow inlet/outlet.

A typical, preferred, flow/pressure regulation valve assembly would comprise a slidable valve member, a biasing member such as a spring, and a valve seat having an aperture therein.

Preferred configurations for components of, or useable in, the assembly are provided. For example, a preferred suction filter assembly is provided. Also, a preferred serviceable filter cartridge arrangement, useable in the liquid filter assembly, is provided. The preferred filter cartridge includes: a primary filter cartridge section and a bypass filter cartridge section secured to one another; and, a first end cap. In the preferred embodiment, the primary filter cartridge section and bypass filter cartridge section are secured to, and on opposite sides of, the first end cap. Also positioned at the first end cap, is a seal arrangement for providing a seal with a central tube, for example a stand pipe, in the assembly with which the filter cartridge is used. A second end cap for the filter cartridge, positioned in an opposite end of the primary filter cartridge

section from the first end cap, includes a seal mount therein which preferably defines a seal plane extending at a non-orthogonal angle to a central axis of the primary filter cartridge section. Preferably the seal plane defines an acute angle with the central axis within the range of 30-60°, inclusive; the term "inclusive" in this context meaning that the end points are included in the range.

Also, for the preferred embodiment, the second end cap of the filter cartridge includes a projection or yoke from a side thereof, opposite the media of the primary filter cartridge section. The projection or yoke preferably includes a central aperture therein, for engagement with the top cover of the filter assembly, during use.

The preferred filter cartridge includes a third end cap, positioned at an opposite end of the bypass filter section from the first end cap. The third end cap can include an optional outwardly projecting contaminant collection arrangement thereon.

Methods of assembly and use are also provided.

Brief Description of the Drawings

Fig. 1 is a schematic, partially cross-sectional, diagram depicting a fluid filter arrangement, according to the present disclosure;

Fig. 2 is a schematic diagram illustrating one example of operation of a liquid filter arrangement, according to the present disclosure;

Fig. 3 is an enlarged, fragmentary, cross-sectional view of a portion of Fig. 1;

Fig. 4 is a view analogous to Fig. 3, of an alternate assembly usable with the arrangement of Fig. 1; and,

Fig. 5 is a depiction of a collection of components that can be assembled to provide a subassembly usable in an arrangement according to the principles of Fig. 1.

Detailed Description

I. An Example Embodiment

The reference numeral 1, Fig. 1, generally indicates a liquid filter arrangement or assembly according to the present disclosure. In Fig. 1, the assembly 1 is depicted in an ordinary orientation for use. Herein the terms "top," "bottom," "above," and "below" are sometimes used to characterize the relative positions of components. When these terms are used, reference is meant to the orientation of Fig. 1, i.e., the typical orientation of use for the assembly 1.

The liquid filter assembly 1 includes a housing 3: comprising a filter head 4 having a body 4a and a removable top or cover 5; and, a side wall 7, which in use depends from filter head 4. In general, the housing 3 defines an internal volume 8, in which: selected internal componentry as defined is contained; and, certain filtering and flow operations, as described herein below, occur. The liquid filter assembly 1 further includes a suction filter assembly 10, as defined herein.

The liquid filter assembly 1 includes, operably positioned therein, a serviceable filter cartridge arrangement 15. By the term "serviceable" in this context, it is meant that the filter cartridge 15 is removable and replaceable; i.e., it can be removed from the liquid filter arrangement 1, and be refurbished or be replaced, periodically, as desired. For the particular, preferred, liquid filter arrangement 1 shown, the serviceable filter cartridge 15 optionally includes two filter sections or components namely: a primary filter cartridge or cartridge section 17; and, a bypass filter cartridge or cartridge section 18. For the particular liquid filter assembly 1 depicted, the primary filter cartridge section 17 and bypass filter cartridge section 18 are secured to one another, and thus are removed and are serviced as an integral unit.

Arrangements are feasible, using selected ones of the principles disclosed herein, in which the primary filter cartridge or cartridge section 17 is not integrally attached to the bypass filter cartridge or cartridge section 18. However, the

arrangement depicted, in which the two are permanently secured to one another (or are integral), is convenient and preferred.

The preferred serviceable filter cartridge assembly 15 further includes, as described below, an end cap and seal arrangement 20, which provides for a preferred mounting and sealing of the serviceable filter cartridge arrangement 15, within the liquid filter arrangement 1.

The preferred liquid filter assembly 1 depicted includes a bypass valve assembly 25, described below.

With respect to the assemblies described herein, in some instances reference will be made to "filtering flow." The term "filtering flow" in this context, is meant to refer to a flow which occurs with passage through media, to provide filtering to the liquid involved in the flow. Alternatively, in some instances reference will be made to "non-filtering" flow. The term "non-filtering" in this context, is meant to refer to a flow between locations, which does not involve passage through a filter media.

Referring still to Fig. 1, typical operation of the various components defined, will be understood from the following. The filter head 4 generally includes a filter body 4a having an inlet 30 and an outlet 31. Herein, the liquid flow inlet 30 will sometimes be referred to as a circulation loop liquid flow inlet, since it is an inlet to the filter head 4 of liquid from a circulation loop in which the liquid circulates to perform its function. Similarly the outlet 31 will sometimes be referred to as a circulation loop liquid flow outlet, since it is an outlet for filtered liquid, from the filter head 4 and thus the assembly 1, for the liquid to be directed into a circulation loop to perform its function. In both instances, the terms are meant to distinguish an inlet/outlet arrangement, discussed below, referenced as the reservoir inlet/outlet, which provides for liquid flow from the assembly 1 directly into a liquid reservoir.

Liquid to be filtered is directed into inlet 30 in the direction of arrow 30a. The unfiltered liquid then flows into annular unfiltered liquid volume 33, around the serviceable filter cartridge assembly 15. In general, volume 33 is referred to as an "unfiltered liquid volume," since the liquid received therein, will generally be received directly from a circulation loop, and will be unfiltered and require filtering. Referring

to Fig. 1, it is noted that for the assembly 1 depicted, volume 33 can be considered to have three general regions: upper region 33a which is immediately surrounded by a portion of the filter head body 4a; middle region 33b which positioned between the housing side wall 7 and the primary filter cartridge or cartridge section 17; and, lower region 33c which is positioned between the housing side wall 7 and the bypass filter cartridge section 18.

In normal operation, from the unfiltered liquid volume 33, the liquid is passed through the primary filter cartridge 17 in the general directions of arrows 34, into central volume 35 defined by the serviceable filter cartridge 15. (This would be a filtering flow.) From the central volume 35 the liquid can pass out of the filter cartridge 15 in a direction of arrow 40 to outlet 31, and outwardly from the assembly 1 in the direction of arrow 41. (The flow from volume 35 through outlet 31 is a non-filtering flow.)

The operation described thus far is a normal operation in which the primary filter cartridge 17 has not been substantially occluded; and, the flow demands of the circulation loop or system in which the liquid filter assembly 1 is positioned are relatively constant both upstream and downstream of the liquid filter arrangement 1. Herein, the flow path indicated by arrow 30a and arrow 41, is generally referenced as a circulation loop for the operation of the equipment involved. Within that loop there may be a variety of pumps, valves and mechanical equipment to be operated. The invention in part concerns providing various mechanical arrangements within liquid filter assembly 1, to ensure that an appropriate level of fluid, and flow of fluid, in that circulation loop is maintained.

To address the event that liquid flow demands in the circulation loop downstream of the assembly 1, i.e., in the direction of arrow 41, are not sufficiently great to require all filtered liquid entering in path 30a to be directed into the circulation loop by passage (after filtering) through outlet 31, an alternate flow direction is provided. In particular, flow from central volume 35 can be directed outwardly from the housing side wall 3, and eventually outwardly from the assembly 1 and into a reservoir, by passage through a reservoir outlet/inlet 42. The term "outlet/inlet" (or

alternatively "inlet/outlet") in this context, is meant to indicate that the passage way 42 is configured to allow flow to exit to the reservoir, or flow to enter from the reservoir, depending on operating circumstances. This is described in greater detail below.

More specifically, for the assembly 1 depicted, flow from the central volume 35 can be directed through a tube or center stand pipe 45, in particular through central flow channel 45a in the stand pipe 45, in the direction of arrow 46 through flow/pressure regulation arrangement 47 and outwardly from the assembly 1 by passage through outlet 48 of the suction filter assembly 10, in the direction of arrow 49. (Flow from volume 35 through outlet 48 is a non-filtering flow.)

In a typical operation, the flow path indicated by arrow 49 would be a liquid flow exit from assembly 1 into a reservoir tank, not shown in Fig. 1. In typical use, although alternatives are possible, a liquid filter assembly 1 in accord with the principles described herein, would be mounted on a reservoir tank with suction filter assembly 10 submerged in the reservoir. Such arrangements are sometimes referred to as "in-tank" assemblies.

With the particular, preferred, liquid filter assembly 1 depicted, flow/pressure regulation valve arrangement 47 is conveniently positioned within the suction filter assembly 10, as described in detail below, although alternatives are possible.

From the above descriptions, it can also be expected that in some circumstances, there may be a flow demand increase downstream of the liquid filter arrangement 1, relative to the liquid volume and flow going into inlet 30. When this occurs, liquid will be drawn from the reservoir in the directions of arrows 50, eventually through the reservoir inlet/outlet 42 into central volume 35. Such a flow will generally be through suction filter 51, in suction filter arrangement 10, and is a filtering flow. A directionally biased flow arrangement 54, preferably as described in detail below, is provided in the suction flow path. The directionally biased flow arrangement 54 allows for entrance of liquid into region 35, but inhibits liquid flow in an opposite direction, so as not to override or disable or proper bypass operation of flow/pressure regulation valve arrangement 47. The preferred directionally biased flow arrangement 54

depicted, is a non-helical spring, valve arrangement. By the term "non-helical spring" in this context, it is meant that the valve closure pressure is not provided by a helical, coiled, spring. This is preferred, for convenient operation and assembly. A particular, convenient, non-helical spring, valve arrangement, is described in detail below.

To protect the equipment in the circulation loop, in circumstances in which the primary filter cartridge section 17 becomes occluded to an undesirable level, a bypass filter arrangement 55 is provided. The bypass filter arrangement 55 includes bypass filter 18 and bypass control valve arrangement 25. In general, should the pressure differential across media 17a in primary filter cartridge section 17 (outside or unfiltered side 17b to inside or filtered side 17c) become sufficiently high, the bypass control valve 25 is configured to open, to allow liquid flow through bypass filter media 18a in cartridge section 18 and into central volume 35, as a filtering flow but without passage through filter media 17a in primary filter cartridge section 17. This flow can then proceed, in the direction of arrow 40 through outlet 31, or into the reservoir by passage through reservoir inlet/outlet 42 and then from assembly 1 via the pathway of arrow 49. (A liquid pressure differential that opens the bypass valve will sometimes be referenced as a "bypass valve liquid opening pressure.")

Now that the basic operation, and general components, of the liquid filter assembly 1 are understood, a more detailed examination will be made of selected component parts. Attention is first directed to the features of the housing 3. For a typical liquid filter assembly 1, filter head 4 will be a cast member, for example made from cast aluminum or other material. Cover 5 is threadably secured to the filter head 4, to close service aperture 5a, with a seal provided by o-ring 60. The cover 5 includes an outer, nut shaped, projection 61 for engagement by a wrench or other tool.

The cover 5 includes positioned internally and centrally, a stem 62, configured to project into a central volume 4b of filter head 4. In use, the stem 62 is positioned in size to press against an upper most portion 15a of a serviceable filter cartridge 15 positioned internally of the housing 3, to ensure that the serviceable filter cartridge 15 is positioned, in extension into the housing 3, at an appropriate position and, to ensure that the cartridge 15 cannot be moved out of its operational (sealed)

position. This will be described below in more detail, in connection with the filter cartridge 15.

The side wall portion 7 of the liquid filter assembly 1 depicted, is separable from the filter head 4. In particular, the body 4a of filter head 4 includes an aperture 63 therein positioned on opposite side or direction of the filter head body 4a from the service aperture 5a and cover 5. The sidewall section 7, projects through, and outwardly from (in use downwardly from), the aperture 63.

In a preferred arrangement, the side wall section 7 comprises a molded plastic component having a shoulder 64 (at an upper end in use) and an opposite (in use bottom) end 65. The side wall section 7 includes a projecting tube 66 which defines the reservoir inlet/outlet 42. Tube 66 will typically have a smaller cross-sectional area, than side wall section 7a. In a typical embodiment, the side wall section 7a and tube 66 will be circular in cross section, with a diameter of tube 66 being at least 10%, typically at least 25% and usually at least 30%, smaller than region 7a of side wall section 7 located above end 65.

As will be apparent from the descriptions below, the smaller diameter of tube 66 relative to side wall section 7a, provides that a suction filter assembly 10 can be attached, to the tube 66, without an overall resulting diameter being generated that is larger than aperture 63. This allows for convenient assembly, as discussed below.

The side wall 7 is sized such that, during assembly, when the top 5 is removed from body 4a, the side wall 3 can be pushed into the housing 3 through the opening 5a provided by the absence of the cover 5, until the shoulder 64 engages shoulder 67 in the filter head 4. Shoulder 64 in the sidewall section 7 is provided with a seal member, for example o-ring 68, to provide for a seal at this location.

Attention is now directed to the serviceable filter cartridge 15. In general the serviceable filter cartridge 15 includes a second (upper in use) end cap and seal arrangement 20, as indicated previously. The end cap and seal arrangement 20, for the particular embodiment depicted, are mounted on an end (in use upper end 70) of the primary filter cartridge 17. The end cap and seal arrangement 20 include an end cap portion 71 which, for example, can be a molded member secured (i.e., potted) to the

primary filter cartridge 17. The end cap portion 71 includes a central aperture 72, for passage therethrough of liquid (from region 35) to be directed in the direction of arrow 40 to circulation loop outlet 31. The end cap portion 71 includes, mounted with a portion in extension over central aperture 72, a yoke or projection 72a. The yoke or projection 72a is configured to project in an opposite direction (from end cap portion 71), from primary cartridge media 17a. The projection 72a is configured to be engaged by projection 62 in cover 5, in use. The projection 72a would have, typically, a central aperture 72b, to receive projection 62.

For the arrangement shown, the aperture 72b is defined by a step, to limit the extent to which the projection 62 can enter aperture 72.

The end cap 70 also includes a mounting ring 73 and a seal 74. In this instance the seal 74 comprises o-ring 75. For the particular embodiment shown, the mounting ring 73 is directed outwardly from a remainder of the end cap 71 and is positioned to secure the seal to define a seal plane that is not orthogonal (or non-orthogonal) to a central axis 78 of the primary filter cartridge 17 (or assembly 1). The term "seal plane" as used in this context, it is meant to refer to a plane in which the material which forms the seal, rests. For example a plane defined by an o-ring 75 is shown at 75a. That is, the plane 75a in which the o-ring sits, will be referred to as the seal plane in this context. The term "seal plane" is not meant to refer to the direction of the seal (radially outwardly, radially inwardly or axially). The term is also not meant to refer to the surface of engagement defined between the seal and the housing. The term "seal plane" is merely meant to refer to a plane 75a defined by the seal member, for example o-ring 75, which creates the seal. The term "non-orthogonal" and variants thereof, in this context is merely meant to refer to a seal plane that does not extend at an angle A of 90° to the axis 78. It may alternatively be said that the seal plane 75a extends at an oblique angle to the axis 78.

In the embodiment of Fig. 1, as a result of the non-orthogonal or oblique angle, the mounting ring 73 divides the internal volume 4a of the filter head 4 into an inlet volume 79 and an outlet volume 80, separated by the o-ring 75. The positioning of the mounting ring 73 (to define a seal plane non-orthogonal to the central axis 78)

allows for a construction in which the inlet 30 and outlet 31 can be positioned generally oppositely to one another in the filter head 4 while not needing to be spaced apart, vertically, at all, or at least not to a great extent. For the particular embodiment depicted in Fig. 1, a center line 30b for the inlet aperture 30 is in a plane below a center line 31b for the outlet flow aperture 31.

Typically, the mounting ring 73 will define a seal plane 75 for seal 74 in which the seal defines a circle in a plane at an upper, acute, angle of about 30-60°, inclusive, relative to axis 78, typically about 40° - 50°, inclusive (for example about 45°). The term "upper" in this context, is meant to refer to an angle between the seal plane and the central axis 78, above the seal plane 75. The term "acute" in this context, is meant to refer to the smallest or less than 90° projection angle between the plane 75 and the axis 78, of the two upper angles. In Fig. 1, the oblique (upper, acute) angle is indicated generally at "A."

The end cap 71, including the mounting ring 73, can be molded from a variety of moldable plastic materials, for example a polyamide (PA). Typically a glass filled polyamide (15-30% glass filled by wt.) would be useable.

Still referring to Fig. 1, it is noted that end cap 71 further includes a shield projection 71a thereon. The seal projection projects downwardly along an outside 17b of the media 17a generally a length of extension far enough to extend to a point 71b at or below a lower most extent of inlet 50 and outlet 31. This will accommodate the seal support or mounting ring 73. It also will inhibit fluid entering inlet 30 from directly impinging upon the media 17a at this location. For a typical cartridge 15, wall or shield projection 71a will extend a distance, along outer surface 17b of the media 17, a distance of at least 15 mm., typically about 25 to 40 mm.

For the particular arrangement shown in Fig. 1, filter media 17a of the primary filter cartridge section 17 is secured to, and in operable assembly and orientation depends from, the end cap 71. A variety of constructions can be used for the media 17a of the primary filter cartridge section 17. It is anticipated that for a typical liquid filter operations, a pleated media 84 configured in a generally cylindrical shape around an open center volume, will be used and preferred. The media may be selected

from many of a variety of types of media, now known or later developed, for liquid filter applications. Typically the media will comprise a non-woven fibrous material, for example cellulose fibers, synthetic fibers, glass fibers or a mixture thereof. Such materials are widely known for use in liquid filtering. Typical pleat sizes would be about 6-15 mm., although variations are possible.

A central support or inner support 85 may be positioned along an inside 17c of the pleated media 17, for support. A perforated metal liner, or expanded metal liner, can be used, for the inner support 85. If a metal-free or reduced metal configuration is desired for the serviceable cartridge 15, an extruded, perforated or porous liner can be used.

The media may be contained within a mesh or similar structure, if desired. The mesh may comprise a metal wire mesh or a plastic mesh, as preferred.

It is noted that in some instances it is preferred to manufacture serviceable filter cartridges from reduced metal or metal-free components, so as to facilitate disposal. It is an advantage to arrangements according to the present disclosure, that the replaceable or serviceable part, i.e., the filter cartridge 15, can be manufactured in a reduced metal or metal-free form. Herein the serviceable filter cartridge 15 will be considered a "reduced metal" component, if it contains no more than 3%, by wt., metal. It will be considered metal-free, if it includes no more than 0.1%, by weight, metal.

In some assemblies it may be desirable to provide the primary filter cartridge 17 with an upstream outer liner, or a liner/valve construction, in accord with the descriptions of the PCT Application No. PCT/US03/19112, filed June 18, 2003, entitled "ARRANGEMENT FOR CONTAINING FILTER CONTAMINANT; ASSEMBLY; AND METHODS," identifying Johan Fobe, Enrico Greco and Julien Dils as inventors and having a priority claim to U.S. Serial Number 60/390,856 filed June 21, 2002; hereinafter "the June 18, 2003 PCT Application" incorporated herein by reference.

At an end opposite end cap 71, the primary filter media 17 is secured to end cap 88. End cap 88 is open, having a central aperture 89. It includes an inner seal

90, in this instance an o-ring 91. The seal 91 is positioned to seal against a portion of inner or center stand pipe 45, since end cap 88 is an open end cap.

Herein, a seal will be considered "radially directed," if the seal provided is directed toward or away from central axis 78. For the particular embodiment depicted in Fig. 1, the inner seal 90 is a radially directed seal, or radial seal.' The particular seal 91 depicted is an inwardly directed seal, when defined with respect to the sealing force from end cap 88, to which it is attached.

Still referring to Fig. 1, attention is now directed to the bypass filter 18. The bypass filter 18 comprises a filter media 94 positioned in extension between opposite end caps 88 and 95. End cap 88, which forms an upper end cap (when operably installed) for the bypass filter 18, comprises a lower end cap (when operably installed) for the primary filter media 17a, for the embodiment shown. Preferably both the primary filter cartridge media section 17a and the bypass filter cartridge section 18 are non-removably secured to the end cap 88. Herein the term "non-removably secured" in this context, is meant to refer to a connection that cannot be broken without damage to one of the components involved. Typically the bypass filter cartridge section 18 and the primary filter cartridge media section 17a would be secured to the end cap 88 by being potted in the material of the end cap 88.

End cap 95 is an open end cap, having open central aperture 96. For a typical bypass arrangement, the media 94 would comprise a plastic or wire screen 93, or similar construction. Generally the media 94 is not intended for long term filtering flow operation, but only to ensure the equipment is appropriately protected during a period in which the primary filter media section 17 has become occluded to an extent that a bypass flow in operation is needed.

In a typical application, the axial length of the media 17a of the primary filter media section 17, i.e., the length in the direction of axis 78, will be at least 3 times (typically at least 4 times) the axial length of the bypass filter media section 18.

Lower end cap 95 is provided with an optional outwardly directed lip 98, positioned such that, when serviceable filter cartridge 15 is drawn upwardly through

housing 3, Fig. 1, the lip 98 can catch sediment in annular volume 33 for removal from assembly 1.

Herein, an outwardly directed structure 98 on an end cap such as end cap 95, which is directed to collect contaminant during withdrawal of the filter cartridge 15 from the housing 3, will sometimes be referred to as a "contaminant collection arrangement" or by similar terminology. The terminology is not meant to indicate any specific structure, other than an outward projection configured to capture or collect contaminant. The particular arrangement 98 depicted in Fig. 11, is an outwardly directed lip sized to engage an inner surface of the side wall 7 and having no apertures therethrough. Thus, sediment in region 33 is directed above lip 98, and liquid in region 33 into bypass filter 18, when the cartridge 15 is listed out of housing 4.

From the previous descriptions, it can be seen that during a servicing operation, cover 5 would be removed, and the serviceable filter cartridge 15, comprising the primary filter cartridge 17 and the bypass filter 18, would be removed. A new filter cartridge (typically analogous in configuration to the removed cartridge 15) would then be reinserted. The new filter cartridge 15 would be pushed downwardly into housing 3 until it seats with seal 90 against center pipe 45. The cover 5 can be then returned, with center stem 62 pressed against projection 72a on end cap 71. Rotational orientation of the serviceable filter cartridge 15, for proper positioning of the mounting ring 73, can be facilitated by providing a shoulder 73a within filter head 4 having a shape also at an oblique (non-orthogonal) angle to the center axis 78, so that the filter cartridge 15 can only be nested in one radial orientation around the axis 78. Generally, projection tip 62a on projection 62, Fig. 1, is sized to be received within aperture 72b in projection 72a, in a rotationally slidable manner. Thus, cover 5 can be rotated, even though, once installed, filter cartridge 15 cannot be rotated due to the arrangement between mounting ring 73 and shoulder 73a.

Proper operation of the bypass filter 18, is controlled by the bypass valve assembly 25. The bypass valve assembly 25 is contained within housing 3, and, for the embodiment shown, it is not removed and replaced during servicing of the filter

cartridge 15. That is, bypass valve assembly 25 is configured and positioned to remain with the housing 3, during servicing operation.

Still referring to Fig. 1, the bypass valve assembly 25 comprises a valve member 100, in this instance a tubular valve member 101 slidably positioned within seat 102. The seat 102 comprises a lower portion 103 of center pipe 45; in the example shown, the lower portion 103 having a slightly larger internal diameter (i.d.) than an upper portion 103a. The valve member 100 is slidably positioned to open or close an aperture arrangement 104, in lower portion 103. The bypass valve assembly 25 is provided with a control biasing member (in this example a spring) 105 positioned under compression between ring 106 and internal shoulder 106a, in center pipe 45 (in this example at a region of transition between portions 103 and 103a, of tube or pipe 45), and shoulder 107, on tubular valve 101. If the pressure in region 109, in particular operating on shoulder 110 on valve member 100 becomes sufficiently large relative to pressure in volume 35, the closing force of the control spring 105 will be overcome, the valve member 100 will slide in the direction of arrow 111, to open apertures 104 to liquid flow therethrough. This opening of the apertures 104 allows for a bypass flow through media 92, into center pipe 45. From there, of course, the liquid flow can either be to region 35 and out to outlet 31 in the filter head 4, or into the reservoir via flow path 49, upon exit through reservoir inlet/outlet 42. Typically, the bypass valve assembly 25 will be configured to open under a differential pressure defined by the equipment manufacturer, of the system in which the filter assembly 1 is installed.

As indicated previously, at end 65 side wall 7 includes, projecting therefrom, a tube section 66 preferably of smaller diameter or cross-sectional area, then region 7a. Within region 66, for the embodiment shown, is positioned a stay structure or ring 113, mounted in tube 66, to contain the bypass assembly 25 in operable position. The ring 113 can be mounted, after the bypass valve assembly 25 is inserted into lower region 103 of tube 45, in a variety of ways, for example through sonic welding, if ring 113 and the tube 7 are both made from appropriate plastic materials.

In general terms, end cap 88, between the primary filter cartridge section 17 and the bypass filter cartridge section 18, can be viewed as a first end cap having a

seal 90 thereon, engaging center tube 45, separating the tube 45 between an upper section 103a and a lower section 103. The upper section 103a will generally have an imperforate side wall (and an open end 103b) and the lower section 103 would have apertures 104 therein (and an open end 103c). End cap 71 can be viewed as a second end cap, positioned at an opposite end of media 17a of the first end cap 88. End cap 95 can be viewed as a third end cap, positioned in an opposite end of bypass filter cartridge section 18 from the first end cap 88.

Attention is now directed to structural features attached to an outlet end 66a, of tube 66. That is, in normal operation, the equipment now characterized will be in operable position below side wall section 7, during operable assembly, typically submerged within a reservoir. With respect to this description, attention is directed to Fig. 3, which is an enlarged, fragmentary, cross-sectional view of a portion of Fig. 1.

In this region of the assembly 1, Fig. 3, attention is first directed to the flow/pressure regulation valve assembly 47. The flow regulation valve assembly 47 includes a valve member 151 mounted within a housing 152. The housing 152 is secured to lower outlet end 66a of housing 3. The valve member 151 is positioned (under biasing pressure or control by a biasing member, in this instance spring 155), into a sealing engagement between top 151a and aperture 156, in circular seat 156a. If the pressure within volume 158 (i.e., the pressure differential across aperture 156) exceeds the opening pressure, the valve 151 will move out of sealing engagement with aperture 156, to allow flow in the direction of arrow 160 into region 161, the flow can then pass through apertures 162 in valve member 151 into center region 163, underneath valve top 151a and outwardly from the liquid filter assembly 1, through outlet 48 in the direction of arrow 49, to the liquid reservoir. Typically, the flow/pressure regulation valve assembly will be configured to open at a selected pressure differential within the range of 0.3 - 0.7 bar, for example 0.5 bar.

As indicated previously, the particular liquid filter assembly 1 depicted, includes a suction filter arrangement 10. The suction filter arrangement 10 includes media 170 positioned in extension between opposite end caps 171 and 172, to surround and define a central volume 173. The media 170 would typically comprise a cylindrical

wire mesh or plastic mesh media, typically pleated, supported by a porous inner liner 174. A variety of alternate media arrangements can be used for the media 170, including for example non-woven media of cellulose synthetic or glass fibers. The choice of media would typically be made for the particular environment of use. However for a typical environment involving hydraulic fluids, the intake filter assembly would typically use a wire mesh or plastic mesh screen.

The end caps 171, 172 can be molded from a polymeric material, such as a polyamide, typically a glass-filled (for example 15-30% glass filled, by wt.) polyamide. When fashioned this way, they can be conveniently secured, during molding, to the media 170.

End cap 171 is shown secured to extension 66, for example by rivets 175 although alternate means of securement (such as adhesive or sonic weld) can be used. An additional seal between end cap 171 and tube 66, if desired, could be provided by a gasket at region or joint 176.

Preferably, the outside dimensions for the suction filter arrangement 10 are such that the suction filter arrangement 10 can be pushed through aperture 63, Fig. 1, along with side wall 7, during assembly. That is, the suction filter arrangement 10 can be mounted on the side wall 7 prior to the side wall 7 being installed in the filter head 4.

Returning to Fig. 3, suction filter arrangement 10 includes, positioned therein, a directionally biased valve arrangement 54. Herein the term "directionally biased valve arrangement" is meant to refer to a valve arrangement that readily allows good liquid flow therethrough in one direction, but generally is configured to inhibit or resist liquid flow therethrough in an opposite direction. A variety of mechanisms can be used to provide for such a directionally biased valve arrangement. The particular one depicted, is a non-helically coiled spring arrangement (or non-helical spring arrangement) that utilizes cut valves (typically flaps) that can open in one direction, but generally not in an opposite direction as described.

The term "non-helically coiled spring arrangement," and variants thereof, in this context, is meant to refer to directionally biased valve arrangement that does not

utilize a helically coiled spring to maintain closure of the valves. The term "flaps" in this context, as will be apparent from the more detailed discussion below, references valve members that can swing or pivot open and closed, as described below.

The term "directionally biased valve arrangement," and variants thereof, in this context, refers to an arrangement other than a simple perforated liner, which is equally open to flow in either direction. A particular preferred configuration is discussed below.

The directionally biased, non-helically coiled spring, valve arrangement 54 is positioned within central volume 173 and is configured so that flow from media 170 into tube 66, is relatively easy, by comparison to reverse flow, i.e., flow from inside tube 66 through the valve arrangement 54 directly to media 170.

The particular directionally biased valve assembly 54 shown, comprises: (a) ring-shaped valve member 175, defining an internal volume 175a around a central axis 175b (corresponding in this instance to axis 78) and including at least one and typically a plurality of cut valves 176 therein; and, (b) an outer support 178 having at least one and typically a plurality of apertures 179 therein. The ring-shaped valve member 175 is positioned within the outer support 178, for proper operation. The cut valves 176 are preferably configured so that they can be biased to open by pivoting (in this instance the flaps 176a can pivot open toward center axis 78). Preferred cut valves 176 have a generally u-shaped orientation, such as that shown. The particular cut valves 176 depicted have a "boxed" u-shape orientation, with each of the centers of the u-shaped cuts, pointed in the same direction around axis 78. By "boxed" in this context, it is meant that the cut valve 176 is formed from three straight cuts, and it is not meant that any particular angles between side cuts 176b and the center cut 176c are required. A variety of alternate cut valve shapes can be used, including, for example, curved u-shapes; i.e., u-shapes with curved center cuts. For the embodiment shown, the u-shaped flaps point around the axis 175b (the term "point" is meant to refer to the direction each u-shape is directed, if it is viewed as an arrow, with edge 176c being the lead edge).

A variety of materials can be used for the ring member 175, a particular preferred material would be spring steel, for example spring steel having a thickness of

about 0.05 to 0.2 mm., typically about 0.1 mm. A single piece of spring steel can be used for the ring member 173, the spring steel piece having been curved in a desired shape to be positioned within the outer support 178.

In general, the outer support 178 has a sufficient internal diameter, to contain the ring member 175 securely therein. The apertures in the outer support 178 are preferably positioned and sized so as to be covered by the cut valves 176 in operation. A mechanical index can be provided between the ring member 175 and outer support 178, for example by providing a rib on the outer support 178 which projects toward center line 78, and by also providing the ring with a gap to engage the rib. Such an indexing arrangement between an outer support and a valve sheet having cut valves therein, is described for example in the June 18, 2003 PCT Application, for a different type of assembly.

It is noted that, as indicated above, some of the features of the directionally biased valve arrangement 54 may be analogous to features for a valve arrangement described in the June 18, 2003 PCT application. However, the operational purpose to the valve arrangement 54 is substantially different from those described in the June 18, 2003 PCT Application. In particular, the valve arrangements described in the June 18, 2003 PCT Application, are generally positioned at an upstream side of media, for example around the outside of a cylindrical media, to contain contaminant against the media in use. The valve arrangement 54 described in the current application, is positioned downstream of the media 170 with which it is associated, and its purpose is to allow liquid flow in one direction, and to inhibit reverse liquid flow. The valve arrangement 54 has no contaminant containment purpose. In fact it is located in a filtered liquid volume.

In general, flow in a direction opposite to arrow 50, i.e., from region 173 through the media 170, is inhibited by the cut valves 176, since they cannot readily be biased outward, i.e., away from center line 78, due to the presence of the outer support 178. As a result, the combination of the ring member 175, with the cut valves therein, and the outer support 178, provides for a directionally biased valve arrangement; i.e., it

provides for less resistance to liquid flow in the direction from media 170 to volume 35, then in the opposite direction, without use of a helically coiled spring.

To facilitate a one-way operation for the flaps 176a, outer support 178 is preferably configured with a structural portion overlapped by the flaps 176a.

Still referring to Fig. 3, it is noted that for the particular assembly 10 depicted, the upper end cap 171 is integral with componentry which defines the outer support 178. Of course alternate configurations are possible. One such arrangement is shown in Fig. 4.

Referring to Fig. 4, like numerals are used to indicate analogous componentry. The basic difference between the assembly of Fig. 4 and the assembly of Fig. 3 relates to selected structural shapes and joints. In particular the media 170 for the suction valve arrangement 200 is shown extending between end cap 201 and end cap 202. End cap 202 is integral with a side wall 203 in which the flow/pressure regulation valve assembly 47 and directionally biased valve assembly 54 are positioned. These components 47, 54 may be as generally described above. Disk or ring 210 provides both: for a sealing seat at aperture 211, for the flow/pressure regulation valve assembly 47; and, also, as a base for the directionally based valve assembly 54. Disc 210 can be inserted through end 212, after the flow/pressure regulation valve assembly 47 has been inserted.

From a comparison of Figs. 3 and 4, a variety of possible componentry configurations and assemblies will be understood. One particular set is illustrated in Fig. 5.

In Fig. 5, components of a pressure regulation valve arrangement and suction valve assembly (usable in arrangements as characterized herein) are shown. Referring to Fig. 5, a ring member is depicted at 300. The ring member 300 may be used in accord with the description above, for ring shaped valve member 175.

A flow/pressure regulation valve member is depicted at 310. This valve member may be used generally and analogously to the valve member 151, Fig. 3. In Fig. 5, a control spring 320 for use with the flow/pressure regulation valve member 310, in accord with spring 155, Fig. 3 is shown.

Also depicted in Fig. 5, is a structural piece 330. The ring member 300 can be inserted into structural piece 330 through upper end 331.

At 332, structural piece 331 is shown with an aperture arrangement therein, through which flow can go, controlled by cut valves 333, in this case flap valves, in ring member 300.

The spring 320 and then the valve head 310 can be inserted into structural piece 330 through end 331, i.e., the end opposite end 340. At end 340, internally, a stop arrangement would be provided, to prevent the spring from passing completely through end 340.

In typical assembly, spring 320 would first be dropped through end 331, with valve head member 310 next. Disc 341 would then be positioned in place above the valve member 310. Ring 300 would then be inserted. The resulting assembly could then be mounted on a tube such as tube 66, Fig. 3, with an end 66a of the tube projecting into the opening 331, to abut ring 300 and secure the flow/pressure regulation valve assembly 47 in place.

Attention is now directed to Fig. 2, with respect to general operation. In Fig. 2, a schematic diagram is provided, for an understanding of the general operation. Referring to Fig. 2, a liquid reservoir is indicated generally at 400. At 401, an inlet line to a filter arrangement for example according to filter 1, Fig. 1, as shown. Line 401 would, for example, correspond to inlet line 30a. Line 402 generally depicts an outlet flow into a circulation system, of filtered liquid. Line 402 would generally correspond to outlet flow path 41, Fig. 1.

At line 405, the primary filter arrangement having filter media is shown. This filter media would generally correspond to the filter media at 17, Fig. 1. In normal flow, then, liquid would enter from flow path 401, go through filter 405, and then, if needed, would exit through exit line 402.

Regulation flow to allow the liquid to go into the reservoir, would be controlled by flow regulation valve 410, Fig. 2. Regulation valve 410 could, for example, correspond to flow/pressure regulation valve assembly 47, Fig. 1. Thus, if the

pressure in line 411 reaches an adequate limit, valve 410 would open up, allowing flow from line 401 to go directly into reservoir 400.

Still referring to Fig. 2, the bypass filter is indicated generally at 420. Should the pressure differential across filter 405, i.e., between regions 421 and 411 (measurable by differential pressure gauge 422) exceed an appropriately defined limit, bypass valve 421 will open, allowing flow through bypass filter 420 into region 411, from which it can be directed either into circulation via outlet line 402, or into the reservoir 400 through flow/pressure regulation valve 410. The filter 420 can generally correspond to bypass filter 18 and the bypass valve 421 can generally correspond to bypass valve 25, Fig. 1.

A suction valve assembly is generally indicated at 440, comprising suction filter 441 and directionally biased valve arrangement 442. Filter 441 can (if desired) generally correspond to filter 51, Fig. 3; and, directionally biased valve arrangement 442 can (if desired) generally comprise arrangement 54, Fig. 1. It will be understood that should there be a need for a liquid from the reservoir 400 into region 411, the liquid can be drawn through filter 441 and through directionally biased valve arrangement 442, into region 411. However, being directionally biased, flow from region 411 is inhibited from going through valve arrangement 442.

From the above principles, it will be apparent that the techniques and principles described herein can be applied in constructions of a variety of configurations, sizes and materials. It is an advantage that the described principles, however, can be applied in a relatively compact unit. The following ranges of dimensions are not intended to be limiting, but rather as an indication of how the principles can be applied, in preferred, compact, orientations. The dimensions refer to dimension lines found in Fig. 1. In particular, dimension G, Fig. 1, would be about 65-85 mm., typically 70-75 mm.; dimension H would typically be 25-45 mm., for example about 32 mm.; dimension I would typically be about 200-250 mm., for example about 227 mm.; dimension J would typically be about 60-80 mm., for example about 70 mm.; and dimension K would typically be about 25-50 mm., typically about 35 mm. In a particular example constructed in accord with Fig. 1, useable dimensions would be as

follows: dimension G, 74 mm.; dimension H, 32.3 mm.; dimension I, 227 mm.; dimension J, 70 mm.; and dimension K, 35.3 mm.

Based on the above descriptions, methods of assembly will be apparent. The methods of assembly generally comprise inserting the various component parts, where indicated, into the assemblies. For example one set of steps of a method of assembly would include inserting components of a bypass valve arrangement through a lower end of a housing and into an interior of a stand pipe, as shown. In general, in the arrangement shown in Fig. 1, the steps would comprise inserting a ring 106a, inserting a spring 105 and then inserting a valve slide 101, followed by closure with a cover 113.

Another method of assembly would include assembling a suction filter arrangement 10 including both a first non-helical coiled spring, directionally biased valve arrangement and a flow/pressure regulation valve arrangement, as shown. One method of assembly was described, in connection with Fig. 5. The particular order of insertion of componentry can be directed, by controlling the shape and size of various components.

Also according to the present disclosure, preferred serviceable filter cartridge arrangement is described. The filter cartridge arrangement includes a first primary filter cartridge section and a second bypass filter cartridge section. The two are joined at a first end cap. The first end cap also preferably includes a seal along an inside thereof, for sealing to a stand pipe during insertion. A second end cap is provided at an opposite end of the primary filter cartridge section, from the first end cap. The second end cap preferably includes a seal mount thereon defining a seal plane extending at a selected angle non-orthogonal to a central axis of the primary filter cartridge section. Preferably the selected, acute, non-orthogonal angle is within the range of 30° - 60°, inclusive. Such an arrangement can easily be accommodated, by molded structural portions of the end cap defining an outer o-ring seal group.

The filter cartridge preferably includes an upper projection (or yoke) on an opposite side of the second end cap, from the side from which the media of the primary filter cartridge extends. This projection preferably allows for flow through an

opening in the second end cap, while at the same time providing a stop to insertion of a projection from a top of the housing.

The second end cap also preferably includes a shield arrangement circumscribing a portion of the filter media of the primary filter cartridge section. The shield section generally extends along an outside of the primary filter cartridge section a length equal to or greater than a diameter of an inlet port or outlet port in a corresponding housing, during use.

In some instances, the bypass filter arrangement can include a third end cap having a contaminant collection projection extending outwardly therefrom.

A method of servicing is provided, which preferably involves steps of opening a top cover of a housing, removing a filter cartridge 15 according to the general descriptions herein, and replacing it with a new, refurbished filter cartridge arrangement.

Methods of use of the assembly were described, in connection with Fig. 2. They generally provide for allowing for flow into and out of a reservoir, under the control provided, as well as a circulating flow, with filtering as described.

What is claimed is:

1. A liquid filter assembly comprising:
   (a) a housing defining an interior and having: a liquid flow inlet; a first circulation loop liquid flow outlet; and, a reservoir liquid flow inlet/outlet; and,
   (b) a suction filter assembly secured to the housing and positioned in a liquid flow communication with the reservoir liquid flow inlet/outlet; the suction filter assembly including:
      (i) an extension of suction filter media defining a central volume;
      (ii) a first, non-helical spring, directionally biased valve arrangement positioned within the central volume; the first directionally biased valve arrangement being positioned and configured to:
         (A) readily permit liquid flow from the suction filter media through the first directionally biased valve arrangement and then through the reservoir liquid flow inlet/outlet into the housing interior; and,
         (B) to resist liquid flow from the housing interior, through the first directionally biased valve arrangement and then into and through the suction filter media.

2. A liquid filter assembly according to claim 1 wherein:
   (a) the first directionally biased valve arrangement comprises a ring-shaped valve member having at least one cut valve therein positioned within an outer support having at least one flow aperture therein.

3. A liquid filter assembly according to claim 2 wherein:
   (a) the ring-shaped valve member has a plurality of flap valves therein and defines an internal volume.

4. A liquid filter assembly according to claim 3 wherein:

(a) each flap valve is a u-shaped flap valve positioned to point around a central axis of the suction filter assembly.

5. A liquid filter assembly according to claim 3 including:

(a) a flow/pressure regulation valve:

(i) positioned within the suction filter assembly at a location surrounded by the suction filter media; and,

(ii) configured to selectively release liquid flow from the housing interior to a reservoir.

6. A liquid filter assembly according to claim 5 wherein:

(a) the flow/pressure regulation valve comprises a slidable valve member; a biasing member; and, a valve seat having an aperture therein;

(i) the slidable valve member being selectively biased, by the biasing member, into sealing relation with the valve seat;

(ii) the valve seat of the flow/pressure regulation valve being positioned between the slidable valve member and the internal volume defined by the ring-shaped valve member of the first directionally biased valve arrangement.

7. A liquid filter assembly according to claim 6 wherein:

(a) the suction filter media is cylindrical.

8. A liquid filter assembly according to claim 7 wherein:

(a) the suction filter media comprises an extension of wire mesh or plastic mesh.

9. A liquid filter assembly according to claim 1 wherein:

(a) the housing comprises: a filter head; and, a housing side wall;

(i) the filter head including:

(A) a filter head body;

(B) a top cover removable from the filter head body to define a service opening in the filter head;

(C) a bottom aperture positioned opposite the openable top cover and service opening;

(D) the first circulation loop liquid flow outlet; and,

(E) the liquid flow inlet; and,

(ii) the housing side wall being positioned to extend through the bottom aperture in a direction opposite the top cover;

(A) the suction filter assembly being secured to an end of the housing sidewall opposite the filter head.

10. A liquid filter assembly according to claim 9 wherein:

(a) the housing side wall is removeably secured to the filter head; and,

(b) the housing side wall and suction filter assembly are sized to be installed by projection through the service opening and the bottom aperture in the filter head body, when the openable top cover is removed.

11. A liquid filter assembly according to claim 10 wherein:

(a) the housing side wall comprises a molded plastic construction;

(b) the filter head body comprises a cast metal piece; and,

(c) the housing side wall is sealed to the filter head body with an o-ring seal.

12. A liquid filter assembly according to claim 11 including:

(a) a serviceable filter cartridge positioned with a portion thereof projecting into the interior of the housing;

(i) the serviceable filter cartridge being sized to be inserted through, or removed from, the service opening when the top cover is removed from the filter head body;

(ii) the serviceable filter cartridge including: a primary filter media section defining a central axis and having opposite ends; and, a bypass filter media section secured to, and separated from, the primary filter media section by a first filter end cap attached to an end of the primary filter media section; and,

(iii) the filter cartridge including a second end cap secured to an end of the primary filter media section opposite an end to which the first filter end cap is secured;

(A) the second end cap having a seal projection thereon configured to define a seal plane extending at a non-orthogonal angle to the central axis of the primary filter media section.

13. A liquid filter assembly according to claim 12 including:

(a) a stand pipe secured within the housing side wall at a position with at least a portion of the stand pipe surrounded by at least a portion of the primary media section and a portion of the stand pipe surrounded by at least a portion of the bypass filter media section;

(i) the first end cap of the filter cartridge being sealed to the stand pipe to define:

(A) an upper stand pipe section surrounded by the primary filter media section; and

(B) a lower stand pipe section surrounded by the bypass filter media section and separated from the upper stand pipe section by the seal between the filter cartridge first end cap and the stand pipe;

(ii) the stand pipe having a central flow interior in non-filtering liquid flow communication with both: the circulation loop liquid flow outlet; and, the reservoir liquid flow inlet/outlet; and,

(b) a bypass valve arrangement positioned within the lower stand pipe section to selectively permit liquid flow through the bypass media section and into the flow interior of the stand pipe, by passage through the lower stand pipe section, in response to a bypass valve opening liquid pressure caused by occlusion of the primary filter media section.

14. A liquid filter assembly according to claim 13 wherein:

(a) the bypass valve arrangement comprises:

(i) a tubular valve member slidably received within the lower stand pipe section and slideable between an open orientation and a closed orientation; and,

(ii) a biasing member position to bias the tubular valve member to a closed orientation until the bypass valve opening liquid pressure is reached.

15. A filter cartridge comprising:

(a) a primary filter cartridge section comprising media surrounding a central volume and defining a central axis;

(b) a bypass filter cartridge section;

(c) a first end cap positioned between the primary filter cartridge section and the bypass filter cartridge section;

(i) the primary filter cartridge section and the bypass filter cartridge section each being non-removably secured to the first end cap;

(ii) the first end cap being an open end cap including a seal member thereon, positioned to seal the first end cap against a tube inside of a filter assembly in use;

(d) a second end cap positioned at an opposite end of the primary filter cartridge section from the first end cap;

(i) the second end cap being an open end cap and including an outer seal mount thereon defining a seal plane extending non-orthogonal to the central axis;

(ii) the second end cap including a central projection thereon extending in a direction opposite the primary filter cartridge; the central projection including an aperture therein, for engagement with a housing top, in use.

16. A filter cartridge according to claim 15 wherein:

(a) the outer seal mount defines a seal plane extending at an acute angle within the range of 30° - 60° with the central axis.

17. A filter cartridge according to claim 16 wherein:

(a) the bypass filter cartridge section comprises a metal or plastic mesh media.

18. A filter cartridge according to claim 17 wherein:

(a) the primary filter cartridge section comprises pleated, non-woven, fibrous media.

19. A filter cartridge according to claim 18 wherein:

(a) the primary filter cartridge section includes an inner support.

Abstract

A liquid filter assembly is provided. The preferred assembly includes a serviceable filter cartridge having a primary filter section and a secondary or bypass filter section. The preferred filter cartridge for the preferred assembly, includes a seal mounted at an angle non-orthogonal to a center axis of the primary filter section, on an end cap which forms an upper end cap, when the filter cartridge is in normal use. Projecting outwardly from the upper end cap, in a direction opposite the media, is preferably provided an outwardly projecting mounting projection or yoke. The preferred assembly includes a bypass valve arrangement and a suction filter arrangement. The suction filter arrangement preferably includes a dimensionally biased valve arrangement, preferably one which is devoid of a coiled spring, to control flow through the suction filter. A flow/pressure regulation valve, to allow flow from an interior of the assembly to a reservoir if needed, is preferably provided.

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Title: LIQUID FILTER ASSEMBLY; AND, METHODS
Attorney Name: Randall A. Hillson Exp. Mail No. EV 347838339 US
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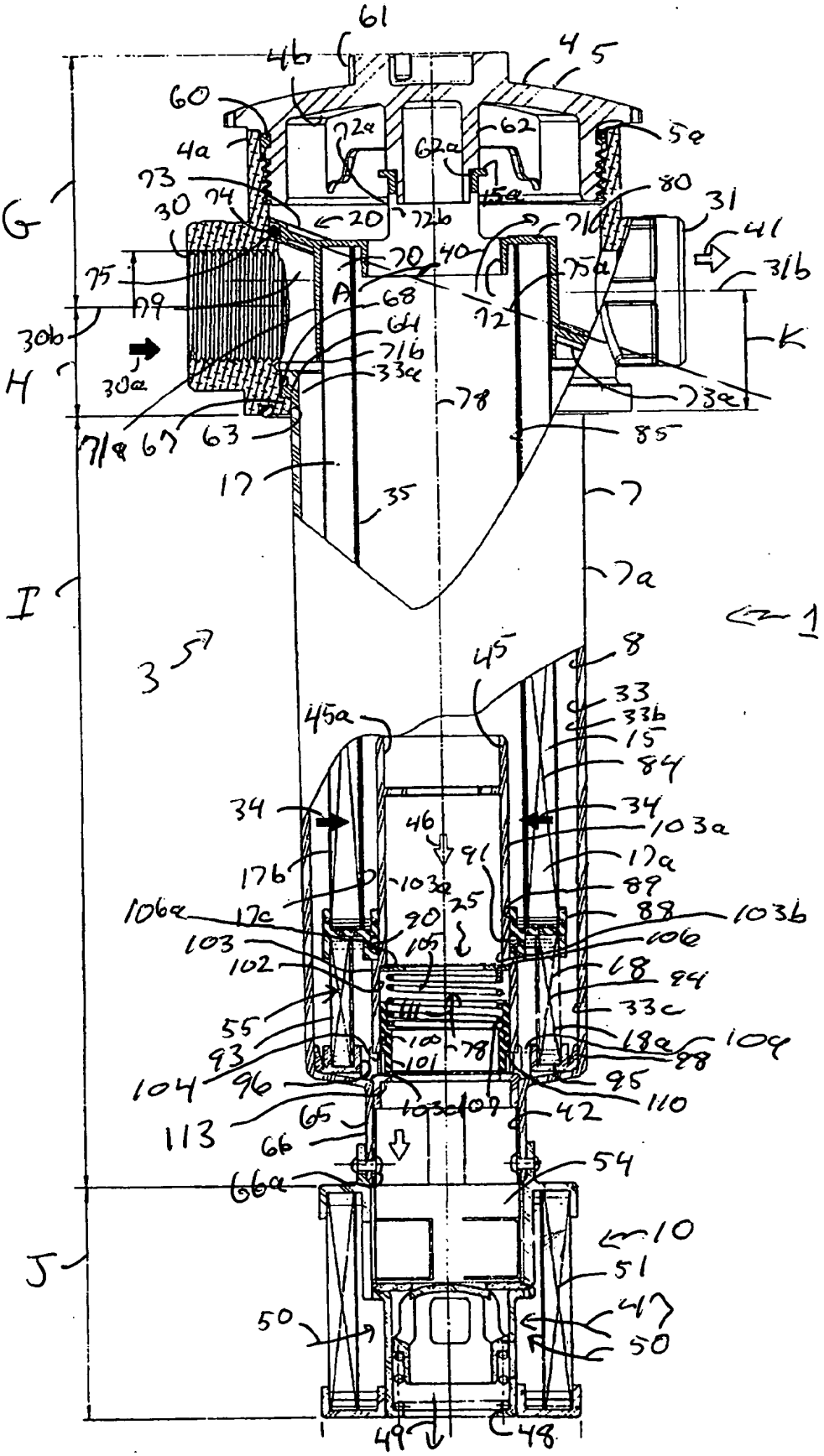
Sheet 1 of 5

FIG. 1



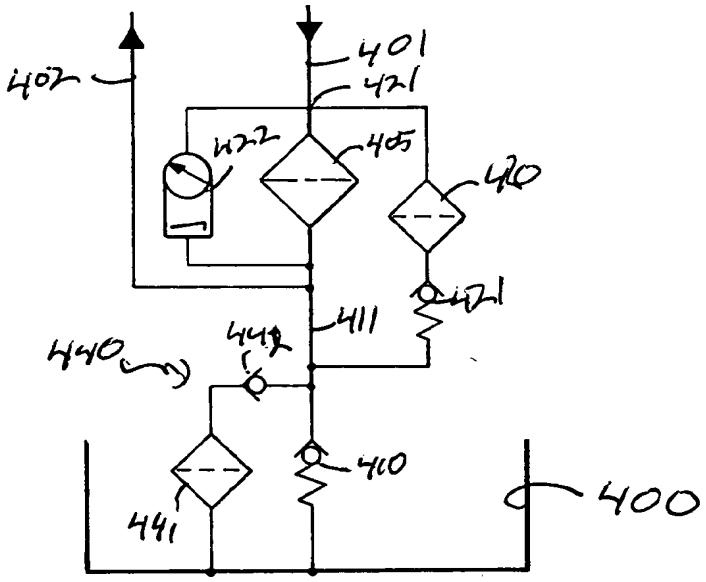


FIG. 2

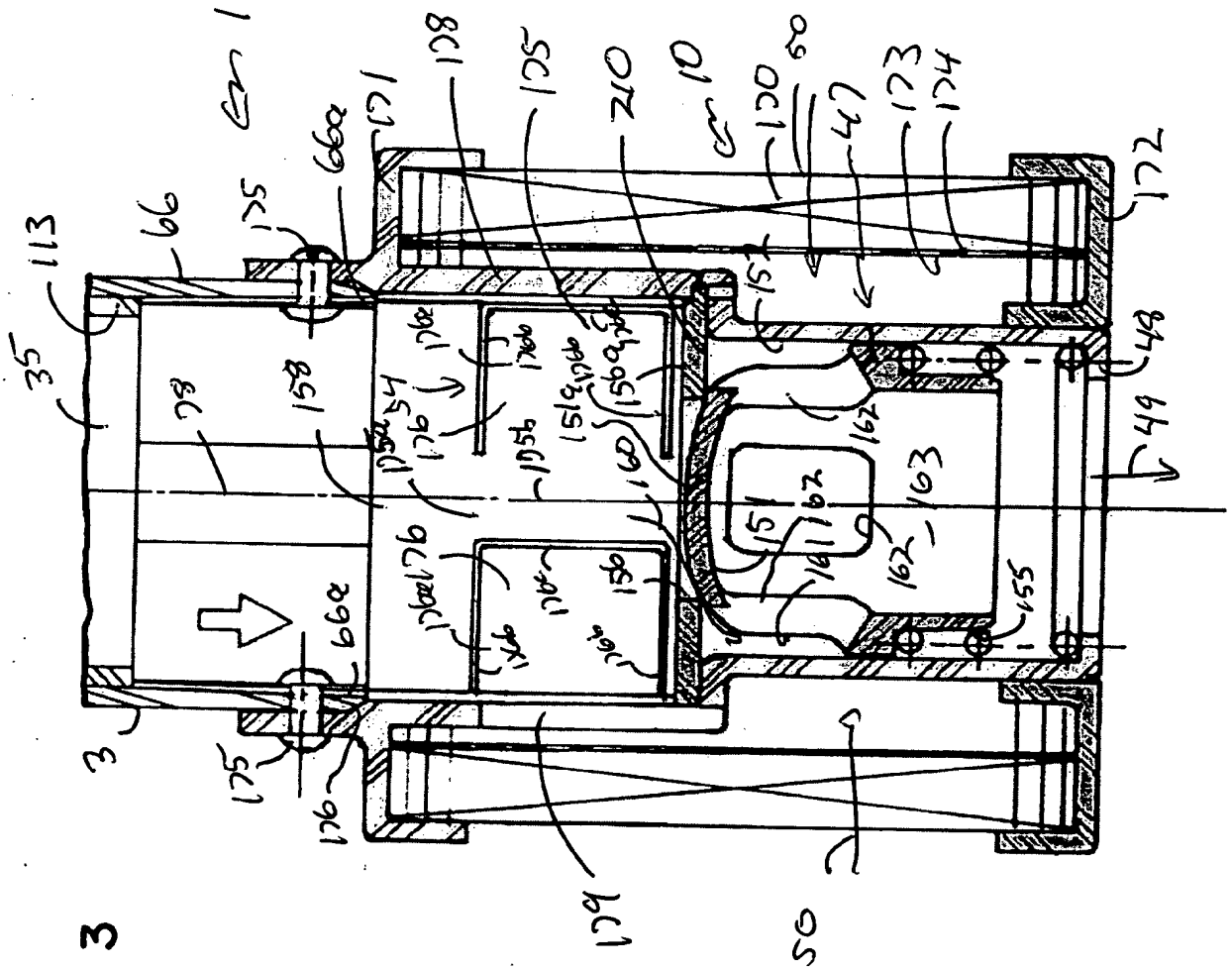
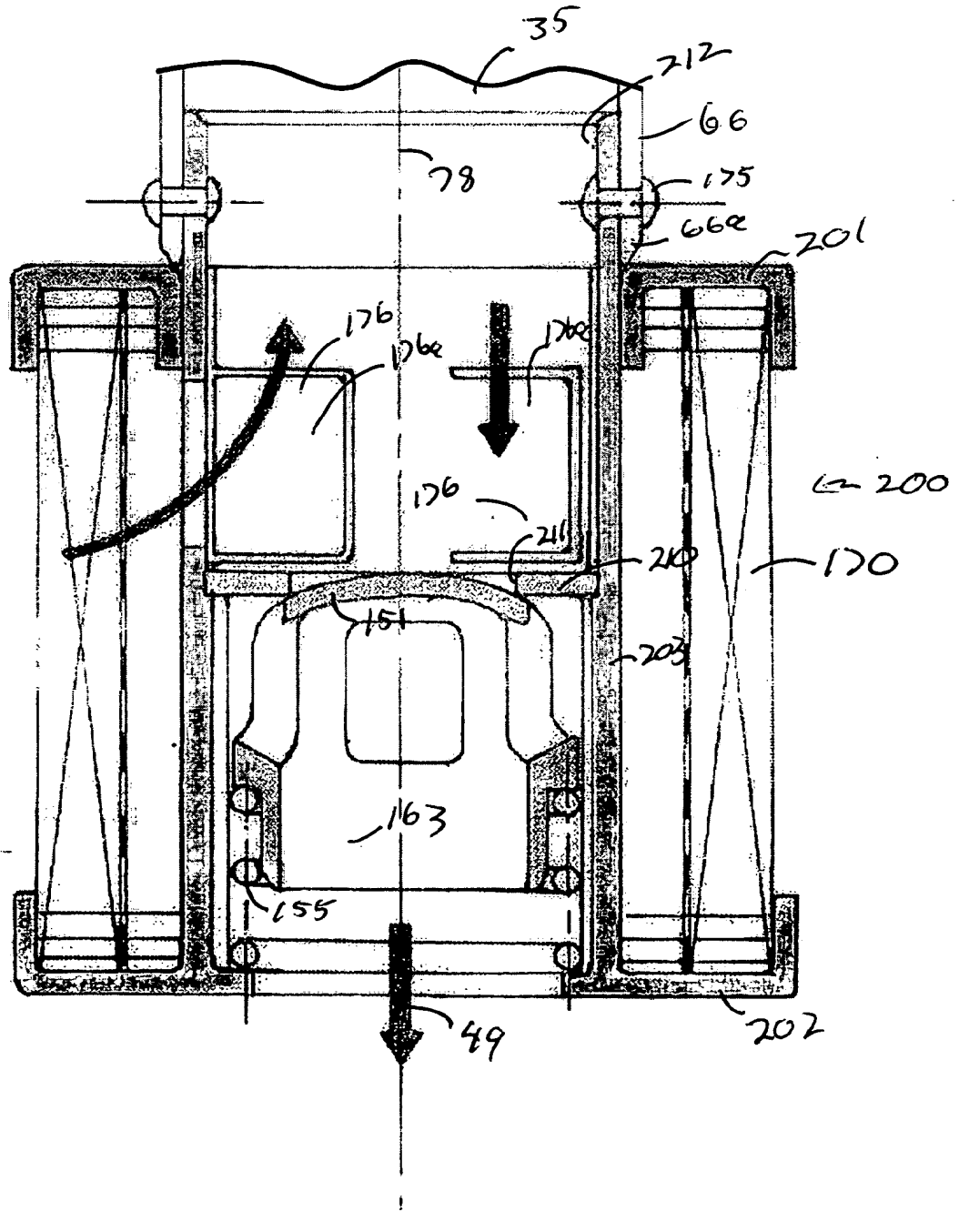


FIG. 3

FIG. 4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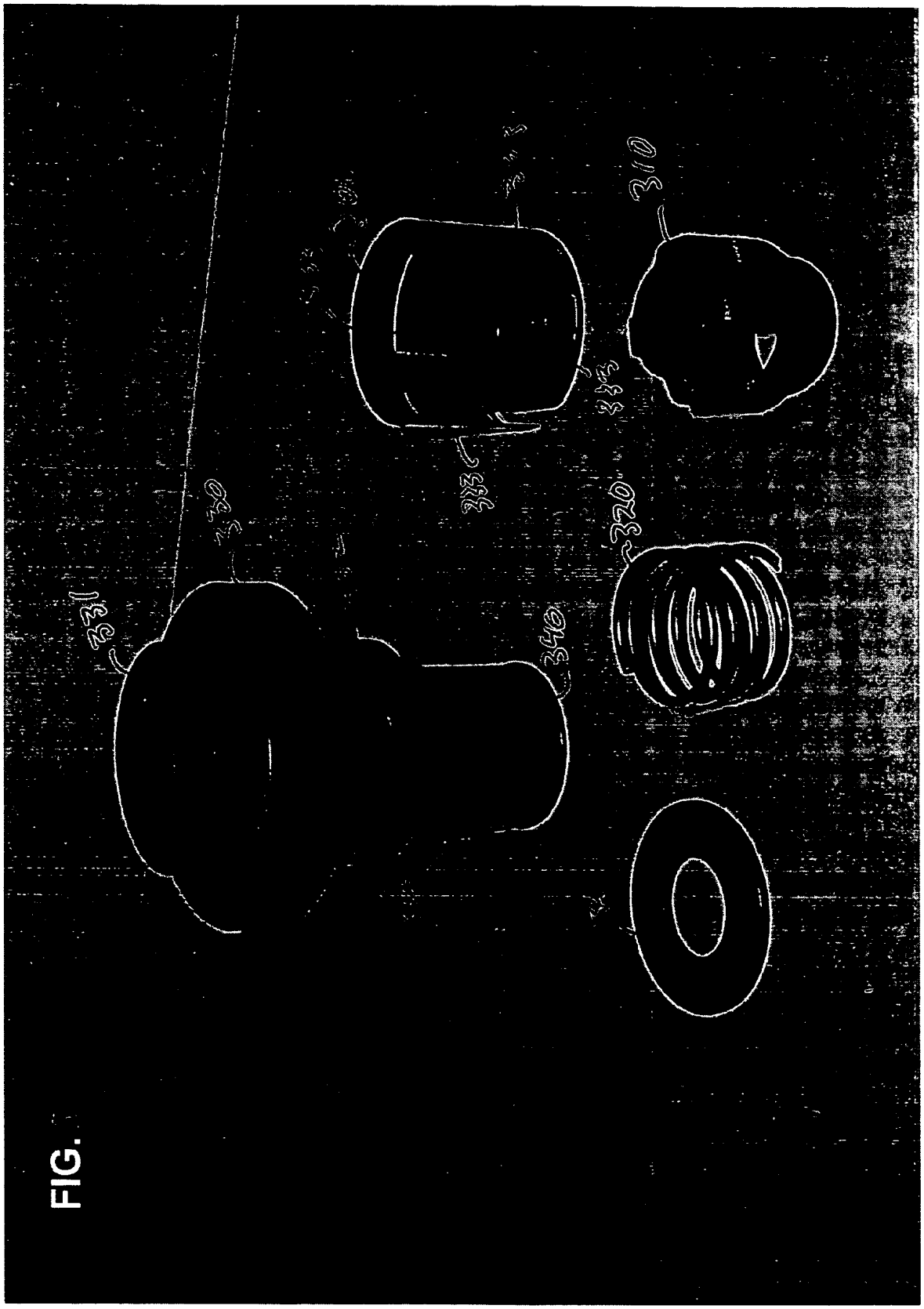

FIG. 3